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(KEY TERMS: cost sharing; economic efficiency; environment; equity; financing; grants; pollution abatement; wastewater; water pollution; water resources; user fees.)

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EFFICIENCY PROBLEMS FROM USER FEES IN MUNICIPAL WASTEWATER TREATMENT[1]

Harold E. Marshall and Rosalie T. Ruegg[2]

ABSTRACT: The Environmental Protection Agency administers a construction grant program to encourage abatement of wastewater pollution by sharing with municipalities the costs of wastewater treatment facilities. The enabling legislation (P.L. 92-500) specifies that EPA's cost share will be 75% of construction costs. It further requires municipalities to collect user fees from industrial users of the facilities to repay that part of the federal grant allocable to the treatment of industrial wastewater. The municipality must return half of the user fees collected to the U.S. Treasury; the municipality is allowed to retain the remaining half. Retention by municipalities of these user fees lowers their effective cost shares and results in the following consequences: (1) a bias for municipalities to select certain kinds of abatement techniques regardless of whether or not they are the least-cost techniques from the national perspective; (2) a bias for municipalities to select larger-than-optimal scales of abatement facilities; (3) a hidden federal subsidy to industry; and (4) grants that favor industrial communities. This article examines the legislative and regulatory requirements for user charges, derives the algebraic expressions for calculating the real federal, municipal, and industrial cost shares with user fees; computes municipal cost shares for selected values of the determinant factors; evaluates efficiency and other consequences of current user fee arrangements; and concludes that the efficiency distortions brought about by the impacts of user fees on cost sharing could be eliminated by requiring that all user fees collected from industry against the federal cost share be returned to the U.S. Treasury.
(KEY TERMS: cost sharing; economic efficiency; environment; equity; financing; grants; pollution abatement; wastewater; water pollution; water resources; user fees.)

I. INTRODUCTION

Through its multibillion dollar Construction Grant Program, the Environmental Protection Agency (EPA) shares with municipalities the costs of constructing wastewater treatment works. The percentage share of abatement costs to be borne by EPA is specified by the Federal Water Pollution Control Act Amendments of 1972 (92nd Congress, 1972), hereafter referred to as the 1972 Act. Federal provisions for user fees, i.e., charges for waste disposal to be levied on users of sewage treatment services, are also

[1]Paper No. 76029 of the *Water Resources Bulletin*. Discussions are open until June 1, 1977.
[2]Chief Economist and Economist, respectively, for the Building Economics Section, Center for Building Technology, Institute for Applied Technology, National Bureau of Standards, Washington, D.C. 20234.

set forth by the 1972 Act. Current user fee arrangements for industrial users affect the actual cost shares (i.e., the proportion of life-cycle abatement costs) borne by federal and nonfederal groups.

Several earlier studies (Marshall and Ruegg, 1974; Marshall and Ruegg, 1975; Davis, 1968; Raymond, 1973) have demonstrated that the share of project costs borne by a municipality influences its choice of abatement techniques and of abatement project scale. Specifically it was shown (1) that applying different cost-sharing rules to different abatement techniques (e.g., applying a higher federal share to conventional plant treatment than to in-stream aeration) will bias municipalities to choose a technique which is least costly to them, but not necessarily to the nation; (2) that applying cost sharing rules which cover only certain types of abatement costs (e.g., capital but not operation and maintenance costs) may also bias municipalities to choose techniques which are not the least costly for the nation; and (3) that providing a federal cost share of a size which reduces the municipality's costs below its benefits at the margin will tend to encourage the municipality to overbuild abatement facilities.

It is shown in this paper that the current user fee provisions in the Construction Grant Program result in, other things equal, (1) a **widening** of the difference among abatement techniques in the percentage of their costs shared by the federal government, and (2) a **further** reduction in the effective cost shares of some municipalities. These characteristics of the current user fee arrangements thereby contribute to economic inefficiencies and inequities in the grant program.

It is our purpose here to show how cost shares of the municipality and the federal government are affected by existing user fee arrangements, to examine the sensitivity of cost shares to factors which determine user fees, to assess the efficiency and other implications of the changes in cost shares that result from the user fee arrangements, and to show how the undesirable user fee effects might be eliminated.

In addition to the Introduction, the paper consists of three main sections. In Section II, the legislative and regulatory descriptions of user charges are examined, and on the basis of these descriptions, the **effective** (actual) cost shares with user fees are set forth algebraically. In Section III, the direction and relative magnitude of change in cost shares are assessed with respect to different factors which determine the amount of user fees, and effective cost shares are computed for selected values of these determinant factors. In Section IV, the effects of user fees on cost shares are assessed in terms of their economic efficiency and other implications, and a means of eliminating the undesirable impacts of the user fee program on effective cost shares is recommended.

II. EFFECTIVE COST SHARES WITH USER FEES

As a point of departure, the federal and municipal cost shares which would result from the federal construction grant apart from user fees are shown algebraically. Then each of the relevant legislative and regulatory requirements is examined for its effect on the actual federal, municipal, and industrial cost shares. The original algebraic expressions of federal and municipal cost shares are revised to show the actual cost shares, taking into account both the formal grant and industrial user fees.

Cost Shares as Defined by the 1972 Act

According to the 1972 Act, the share of abatement costs to be borne by EPA is 75% of the eligible construction costs (K) of a treatment works. Construction costs include the costs of planning, capital, and land that is an integral part of the treatment process; but they exclude costs of site acquisition, operation and maintenance (O&M), and most other costs. Thus, the formal federal grant can be expressed as .75K.

Accordingly, the share of construction costs left to the municipality is .25K. Since the formal grant excludes costs other than construction costs, the municipality must cover 100% of these other costs (C), in addition to the remainder of construction costs, or a total of .25K + C. (Changes in municipal cost shares resulting from state or regional funding of abatement projects are not considered here.)

Under the final regulations of the Construction Grant Program, the 75% share is interpreted to apply to "any segment" of a treatment works, and it is not required that the federal share amount to 75% of total construction costs of the completed facility. Thus, .75K comprises the maximum federal share of total construction costs, and .25K the minimum municipal share.

The federal (S_F) and municipal (S_M) cost shares without user fee effects can therefore be expressed as

$$S_F \leq \frac{.75K}{TC} \quad \text{and} \tag{1}$$

$$S_M \geq \frac{.25K + C}{TC}, \tag{2}$$

where

S_F = the federal agency's legislated share of total abatement cost, apart from user fee effects,

K = total costs of construction including both industrial and nonindustrial facilities (i.e., planning, capital, and eligible land costs);

TC = present value of total costs of a completed abatement facility to treat both industrial and nonindustrial wastewater over its life, i.e., K + C;

S_M = the municipality's legislated share of total abatement cost, apart from user fee effects;

C = present value of other costs of the treatment works, consisting mainly of O&M costs over the life of the abatement facility and land costs not eligible for federal cost sharing.

Since industrial charges or user fees are not yet being considered, and there are only two participants in the cost-sharing program, $S_F + S_M = 1$.

Legislative Requirements and Federal Regulations which Establish User Fees

Legislative requirements for user fees are the following: (1) User fees are to be collected from all recipients of services to repay their proportionate share of O&M

expenses. (2) User fees are to be collected from industrial users to repay that portion of the federal grant allocable to treatment of industrial wastewater. (3) The grant recipient (i.e., the municipality) shall retain 50% of industrial user fees collected against the federal grant (92nd Congress, 1972). (Although the 1972 Act actually specifies two alternative allowable amounts to be retained, only one of the alternatives, i.e., retention of 50% of industrial user fees, will ever apply [Marshall and Ruegg, 1974].)

Federal regulations further govern existing user fee administration through the following provisions: (1) User fees to recover the industrial share of the grant are to be collected in equal annual payments over the life of the treatment works (or 30 years, whichever is less). (2) Industrial user fees shall not include an interest charge. (3) Twenty percent of retained user fees may be used by the municipality as it chooses. (4) Eighty percent of retained user fees must be placed in a reserve fund (held in government-issued or government-guaranteed securities or accounts), the principal and interest thereon to be used solely for eligible costs related to expansion or reconstruction of the project from which the user fees are derived. (5) If a subsequent grant is made, the unexpended balance in the reserve fund must be deducted from eligible project costs for purpose of determining the size of that grant. (This regulation is interpreted to mean that the amount in the reserve fund at the time a new grant is awarded must be applied to the project costs for which that grant is made, but the fund need not be held until a grant is forthcoming; i.e., it may be used for eligible and approved costs apart from any future grant [*Federal Register*, 1974].)

Effects of User Fee Requirements and Regulations on Cost Shares

Now let use examine each of these three legislative requirements and five federal regulations in stepwise fashion to determine their impact on the cost shares shown by equations 1 and 2.

So far we have discussed federal and municipal shares, assuming that the industrial sector was a part of the municipality. Now let us consider the industrial sector as distinct from the municipality so that we have three cost-sharing participants.

The first legislative requirement is that user fees be collected from service recipients to repay their share of O&M costs. This means that the industrial community reimburses the municipality through the payment of user fees for the portion of O&M costs for which it is responsible. The federal agency's cost share is unaffected; the municipality, which is ultimately responsible for the full cost of O&M, recoups that portion of the O&M cost attributable to the industrial community; and the industrial sector pays the municipality for services rendered to it. Since the focus of this paper is on how industrial user fees collected against the federal grant impact upon relative cost shares, the municipal and industrial cost shares will be calculated and shown algebraically here without reference to industrial user fees for O&M. Thus user fees hereafter refer only to those collected against the federal construction grant.

The second and third legislative requirements, which direct the grantee to collect user fees from industry equal to industry's share (β) of federal construction grant funds and to retain half, do affect the federal as well as the municipal and industrial cost shares. The federal share is reduced by the amount of industrial user fees it receives. The municipal cost share is altered because some part of the collected fees is retained by the

municipality, whereas the cost share which they ostensibly cover is the federal government's and not the municipality's. Thus, the federal government receives only half the user fees collected against its share of construction costs required to build that part of the treatment facility used to treat industrial wastewater. The municipal government receives the other half of the industrial user fees, although it does not incur the costs against which the fees are collected. The retained user fees constitute, in effect, an additional federal subsidy to the municipality which reduces the municipality's share of total life-cycle costs.

In light of these three legislative requirements, one would conclude that the industrial user fee to be collected is equal to $.75\beta K$, and that the amount to be retained by the municipality is equal to $(.50)(.75\beta K)$, where β is the proportion of the federal grant allocable to the treatment of industrial wastewater.

While the three legislative requirements alter the cost shares, the five federal regulations influence the amount of change in cost shares which is induced by user fees. These five regulations govern the user fee collection period, the inclusion of interest charges in user fees, and the use of the retained revenue.

The first two federal regulations together reduce the present value of user fees to be collected below the amount of costs they are to cover by specifying collection of user fees in equal increments over the life of the facility, or 30 years, without an interest charge. This reduction results because the user fees are collected over time with no compensation for the positive time preference of money. The longer the collection period and the higher the applicable discount rate, the greater will be the difference between user fee revenue and costs. A federal interest subsidy to industry for the treatment of industrial wastewater results.

It is necessary to adjust the amount of industrial user fees by an appropriate discounting formula to find its actual value. Rather than simply being equal to the portion of the grant allocable to industry, i.e., $.75\beta K$, as called for by the legislative requirements, the amount of industrial user fees collected is equivalent in present value terms to the following:

$$U = \sum_{j=1}^{n} \frac{.75\beta K}{n(1+i)^j}, \tag{3}$$

where

U = the present value of industrial user fees;

n = the length of the collection period in years;

β = the proportion of the federal grant allocable to the treatment of industrial wastewater;

$\frac{.75\beta K}{n}$ = the amount to be collected each year;

i = the discount rate; and

$\frac{1}{(1+i)^j}$ = the single present value discounting term.

It follows that the amount retained by municipalities is equal to half of U, while the remaining half goes to offset part of the federal cost for constructing facilities to treat industrial wastewater.

The third and fourth regulations instruct that the user fee revenue retained by the municipality is to be divided into two parts. Twenty percent is to comprise a discretionary fund (D) for use by the grantee as it chooses, where

$$D = \sum_{j=1}^{n} \frac{(.20)(.50)\,.75\beta K}{n(1+i)^j} = \sum_{j=1}^{n} \frac{.075\beta K}{n(1+i)^j} = .1U. \tag{4}$$

Eighty percent is to become a reserve fund (R) to pay for approved, eligible construction costs, where

$$R = \sum_{j=1}^{n} \frac{(.80)(.50)\,.75\beta K}{n(1+i)^j} = \sum_{j=1}^{n} \frac{.3\beta K}{n(1+i)^j} = .4U. \tag{5}$$

Thus,

$$D + R = .5U. \tag{6}$$

The fifth regulation requires that, in the future, when a subsequent grant for a new project is received, the new eligible project costs (K') must be reduced by the amount then in the municipality's reserve fund. The new federal grant is then to be based on the remainder of eligible project costs, i.e., the maximum new federal grant is equal to $.75(K'-R)$.

Because the 20% of retained user fees which is discretionary may be used at any time and in any way the municipality desires to use it, the municipality derives full value from the discretionary fund. And, because it is collected against the federal cost share but is given to the municipality, the discretionary revenue can be construed as a federal subsidy to the municipality in the amount D.

Because the reserve portion of retained user fees reduces the amount of future grants, it may appear at first glance that the value of the reserve fund is offset by loss of future subsidy and, therefore, does not yield a net subsidy to the municipality. Closer examination, however, shows that the reserve fund does reduce the municipality's cost share, because it is applied to construction costs with a less-than-equal reduction in the amount of future grants received. In evaluating the amount of federal subsidy accruing to the municipality from the reserve fund, it is necessary to account for the twofold effect: (1) the application of R to future construction costs, and (2) the reduction in future grants which may result.

Deduction of the fund from future eligible costs will constitute a federal subsidy to the municipality only to the extent that these costs would otherwise be borne by the municipality. If there were to be no future federal cost sharing, the municipality would bear the total costs of future abatement in absence of the reserve fund. In this case, deduction of R from costs would provide a federal subsidy to the municipality equal to

R. If, on the other hand, a federal grant were expected to cover 100% of future construction costs, R would be applied to future federal costs only and would provide no additional subsidy to the municipality. But with continued federal/municipal sharing of construction costs, reduction of these costs by R would reduce the municipality's cost share by a fraction of R.

Under the existing cost-sharing rule of a 75% federal share and a 25% municipal share, the reserve fund would reduce the municipality's future costs by .25R provided it were used in conjunction with a future grant. This reduction would result because the reserve fund would be applied against total future eligible project costs (K'), rather than directly against the future grant, thus making the municipality's share .25 ($K'-R$), rather than .25K'. However, recall that it is allowable for the reserve fund to be used for eligible project costs **apart** from any grant award. This provision in the fifth regulation provides a municipality with the opportunity of managing the fund in a way which reduces its cost by more than .25R. That is, the municipality might be able to apply the reserve fund to those eligible project costs for which it has a low probability of obtaining a future grant, thereby avoiding the reduction of future grant funds and capturing up to the full value of R rather than just .25R. A low probability of obtaining a grant might result, for example, because of a general inadequacy of federal grant funds, or because of low priority of that particular project in the grant process. Examples of eligible costs which might be accorded high priority by the municipality, but low priority by the grant administrator, are costs of projects which involve sewage collection-related benefits (benefits which accrue almost completely locally), as opposed to projects providing more totally treatment benefits (benefits which are more likely to extend beyond the local community). If the total reserve fund revenue were used apart from future grants, the municipality would derive 100% of its value.

Hence, under existing cost-sharing rules, R and .25R can be identified as upper and lower bounds, respectively, on the amount of federal subsidy resulting from the reserve fund. The specific proportion depends upon the part of the reserve fund which is expended on projects that are unlikely to receive a federal grant. (The terminology "new or future eligible costs" (K') has been introduced above for the purpoee of explaining how the reserve fund impacts on cost shares; however, for simplicity, the K' notation has been excluded from the following cost-sharing equations [7], [8], and [9].)

Cost Shares as Altered by User Fees

The federal and municipal long-run cost shares can now be redefined algebraically to take into account the effect of industrial user fees, including the portion received by the federal government, and the discretionary and reserve funds retained by the municipality. A new equation is added to illustrate the industrial cost share.

$$\bar{S}_F \leq \frac{.75K - .5U - .75R(1-\alpha)}{TC}, \tag{7}$$

$$\bar{S}_M \geq \frac{.25K + C - D - R(.75\alpha + .25)}{TC}, \text{ and} \tag{8}$$

$$\bar{S}_I = \frac{U}{TC} \tag{9}$$

where

$\bar{S}_F$ = the federal agency's effective share of life-cycle abatement costs, taking into account the effect of industrial user fees on cost shares;

α = the percent of R to be used for the future costs of eligible projects which the municipality will undertake, but for which grant funds are not expected;

$\bar{S}_M$ = the municipality's effective share of life-cycle abatement costs, taking into account the effect of user fees; and

$\bar{S}_I$ = the industrial community's effective share, considering only its contributions against the federal construction grant.

By comparing equation (8) (which shows the municipality's effective cost share with user fees) with equation (2) (which shows the cost share without user fees), it can be seen that industrial user fees collected against the federal cost share result in a reduction in the municipality's portion of costs equal to $D + .75\alpha R + .25R$. For example, if all of the reserve fund were expended apart from future grants, i.e., if $\alpha = 1$, the municipality's cost share would be reduced by the full value of the user fees retained (i.e., $D + R(.75(1) + .25) = D + R$ or $.5U$). If, on the other hand, only half of R were applied against future grants and half apart from grants, i.e., if α were .5, the municipality's cost share would be reduced by $D + R(.75(.5) + .25) = D + .625R$.

From equation (7), we see that the federal cost share is reduced by the half of user fees which goes initially to the federal government, as well as by that portion of the municipality's reserve fund which is eventually credited against future federal grants. If, for example, $\alpha = 1$, i.e., if the municipality uses its reserve fund entirely apart from future eligible costs, we see from equation (7) that $.75R(1-\alpha) = 0$, and the reserve fund does not reduce the federal cost share. However, if the municipality applies, say, half of the reserve fund against future grants and half apart from grants (i.e., if $\alpha = .5$), the federal cost share will be reduced by an additional amount equal to .375R.

Note that $\bar{S}_F + \bar{S}_M \leq 1$. The combined, maximum effective contribution by the federal and municipal governments will be just equal to total treatment costs if $\beta = 0$ (i.e., if industrial wastewater is **not** treated in municipal facilities), and will be less than total treatment costs if $\beta > 0$ (i.e., if industrial wastewater is treated in municipal facilities). If $\beta > 0$, the industrial sector of the community provides a portion of total treatment costs through its contribution of user fees, and thereby becomes in effect a third cost-sharing participant. Thus, the complete cost-sharing perspective with user fees is described as follows:

$$\bar{S}_F + \bar{S}_M + \bar{S}_I = 1.0 \tag{10}$$

III. SENSITIVITY OF EFFECTIVE COST SHARES TO FACTORS WHICH DETERMINE USER FEES

Equations (7) and (8) show that the effective federal and municipal cost shares are dependent upon a number of variables: the degree of community industralization, β; the ratio of grant-eligible and ineligible costs associated with the particular abatement technique(s), $\frac{K}{C}$; the method of expending the reserve fund, as indicated by α; the length of project life, n; and the discount rate, i. The effective cost shares are likely, therefore, to differ among communities and among projects. To determine how significant each of these variables is, we will assess the sensitivity of the municipal effective cost shares to selected values of each variable. (The implications for federal cost shares could also be traced, but we treat only the municipal share here because of our focus on the municipality.)

By inspection of equation (8), we can see that the larger are D and R, the smaller will be the municipality's cost share. From the definitions of D and R, we can further see that the size of these funds increases as β, the proportion of the grant allocable to treatment of industrial wastewater, increases. Where $\beta = 0$ (i.e., for a purely residential community or one which does not treat industrial wastes in the public sewage system), the values of R and D are zero, and the effective municipal cost share is simply .25K + C. But where $\beta > 0$ (i.e., where industrial sewage is treated in the municipal treatment facility), D and R have positive values, and the municipality's cost share is reduced below .25K + C. The more industrialized the community, the larger the potential β, and the smaller the municipality's effective cost share may become.

It can also be determined that the proportion of grant-eligible to grant-ineligible costs for the given abatement technique, i.e., the ratio K/C, further influences the amount of change in cost shares due to user fees. It is this ratio which determines the relative effective cost shares rather than the absolute size of total abatement costs. (As indicated earlier, it is the application of cost-sharing rules that do not cover equally all categories of costs to techniques which differ in their cost composition; i.e., which vary in their K/C ratios, that is a prime factor in causing variable federal and municipal cost shares apart from user fees.)

From equation (8), we can see also the direction of impact of α on the effective municipal cost shares. The larger α, the lower the effective cost share, thus demonstrating that by skillful management of its fund, a municipality might over a period of time reduce its effective cost share below what it otherwise would be.

There remain two additional variables which influence cost shares: n, the length of the period over which the user fees are to be collected, and i, the appropriate discount rate. Because the user fees do not include an interest charge, the present value of the user fees collected become smaller the longer the collection period; hence, the shortfall between the user fees and the costs they are intended to cover becomes larger. Other things equal, the municipality's effective cost share therefore increases as n increases. The larger the appropriate discount rate i, the more serious is the omission of interest from user fees, and the larger the municipality's effective cost share.

Table 1 shows effective municipal cost shares computed for selected values of the preceding five variables, β, K/C, α, n, and i. The table lists cost shares for values of β ranging from 0 to 1; for three values of K/C, viz. 1/9, 1/1, 9/1; and for the lower and

TABLE 1. The Sensitivity of Effective Municipal Cost Shares to Determinant Variables.

	Municipality's Percentage Share of Construction Costs Only		Municipality's Percentage Share of Total Costs for Projects with Different Proportions of Grant-Eligible to Ineligible Costs					
			K/C = 1/9		K/C = 1/1		K/C = 9/1	
β	α = 1	α = 0	α = 1	α = 0	α = 1	α = 0	α = 1	α = 0
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. The Effective Municipal Cost Share Computed for a Project Whose Expected Life is 35 Years, with a Discount Rate of 10%								
(1) 0*	25.0		92.5		62.5		32.5	
(2) .1	22.8	24.5	92.4	92.5	61.9	62.3	31.4	32.1
(3) .2	22.6	24.1	92.3	92.4	61.3	62.0	30.4	31.7
(4) .3	21.5	23.6	92.1	92.4	60.7	61.8	29.3	31.2
(5) .4	20.3	23.1	92.0	92.3	60.1	61.6	28.3	30.8
(6) .5	19.1	22.6	91.9	92.3	59.6	61.3	27.2	30.4
(7) .6	17.9	22.2	91.8	92.2	59.0	61.1	26.1	30.0
(8) .7	16.8	21.7	91.7	92.2	58.4	60.9	25.1	29.5
(9) .8	15.6	21.2	91.6	92.1	57.8	60.6	24.0	29.1
(10) .9	14.4	20.8	91.4	92.1	57.2	60.4	23.0	28.7
(11) 1.0	13.2	20.3	91.3	92.0	56.6	60.1	21.9	28.3
B. The Effective Municipal Cost Share Computed for a Project Whose Expected Life is 10 Years, with a Discount Rate of 7%								
(12) 0*	25.0		92.5		62.5		32.5	
(13) .1	22.4	23.9	92.2	92.4	61.2	62.0	30.1	31.6
(14) .2	19.7	22.9	92.0	92.3	59.9	61.4	27.8	30.6
(15) .3	17.1	21.8	91.7	92.2	58.5	60.9	25.4	29.7
(16) .4	14.5	20.8	91.4	92.1	57.2	60.4	23.0	28.7
(17) .5	11.8	19.7	91.2	92.0	55.9	60.0	20.6	27.8
(18) .6	9.2	18.7	91.0	91.9	54.6	59.3	18.3	26.8
(19) .7	6.6	17.6	90.7	91.8	53.3	58.8	15.9	25.9
(20) .8	3.9	16.6	90.4	91.7	52.0	58.3	13.5	24.9
(21) .9	1.3	15.5	90.1	91.6	50.6	57.8	11.2	24.0
(22) 1.0	−1.3	14.5	89.9	91.4	49.3	57.2	8.9	23.0

* Where $\beta = 0$, there are no industrial wastes treated; hence, there are no retained user fees, and cost shares are unaffected by user-fee arrangements.

upper limits of α, i.e., $\alpha = 0$ and $\alpha = 1$. The difference in the two parts of the table is that Part B assumes a shorter n and a lower i than Part A.

Rows 1 and 12 of the table show cost shares computed without retained user fees (i.e., where $\beta = 0$). The wide range (from 32.5% to 92.5%) in the municipality's share of total cost which may be seen in these two rows is independent of the retention of user fees. It results solely from variations in the proportion of grant-eligible and grant-ineligible costs for the abatement technique which is used. The municipality's cost share drops from 92.5%, when construction costs comprise only 10% of total costs, down to 32.5% when construction costs comprise 90% of total costs. (For a more in depth treatment of this effect alone, see Marshall and Ruegg [1974].)

The remaining rows of the table reveal how the user fee program alters legislated cost shares still further. Rows 2 through 11 show effective cost shares for increasing values of β, computed for a project life of 35 years and a discount rate of 10%. Rows 13 through 22 show the same thing, but computed for a project life of 10 years and a discount rate of 7%. The declining values in each of the columns show that the effective municipal cost share declines with increases in β.

Columns 2 and 3 of the table show the municipality's effective share of construction costs only. The effective shares of construction costs are affected by β, n, and i, but are constant for different levels of construction costs and for different ratios of construction to other costs, other things equal. The municipality's share of construction cost is shown to fall increasingly below 25% as β increases and as n and i decrease. The share even becomes negative (row 22, column 2) when a large part of the treatment costs are accounted for by industry, a relatively low discount rate is applied, the collection period is short, and the user fee revenue is used to full advantage. A negative share means that the present value of the retained user fees collected against the federal cost share exceeds the municipality's 25% nominal share of construction costs. Because the probability of all these conditions occurring is rather low, negative shares of construction costs in practice appear unlikely. The circumstances whereby a municipality's effective share of construction costs could fall substantially below 25%, however, appear quite possible.

Columns 4 through 9 show the municipality's effective share of total costs for different K/C ratios. By going down columns 4 and 5, we can determine that user fees will have little impact on effective cost shares when construction costs comprise a very small part of total costs. For example, in row 6, column 4, we can see that user fees reduce the effective cost share by only about one-half percentage point (from 92.5% to 91.9%) even for the relatively large value of β of .5. From columns 8 and 9, on the other hand, it appears that the impact of user fees may be substantial when the abatement project is construction-intensive (i.e., when K/C is high). When construction-intensive techniques are selected, user fees may reduce the municipality's effective cost shares by as much as several percentage points even for low values of β. For example, in column 8 we see that the effective cost share is reduced from 32.5% (row 1) to 30.4% (row 3) when β changes from zero to .2. As may be seen by row 22, column 8, the municipality's effective cost share is reduced to only 8.9% for the relatively high values of K/C, β, and α and for the low values of n and i which are assumed in Part B of the table.

Table 2 shows, for a hypothetical case, what a municipality's abatement costs would be with and without the retention of user fees. Based on the assumptions given in the table, the effect of current user fee policy would be to reduce this municipality's construction costs by an amount ranging from approximately $80,000 to $200,000 (see table 2, row 3), depending upon how the municipality uses its reserve fund. This amounts to a reduction in the municipality's share of construction costs of between approximately 2 percent and 4 percent – a small percentage reduction in cost, but doubtlessly a significant dollar amount of savings to a municipality in these days of financial strain. (This example is based on conservative assumptions, and the cost effect could in practice be much more dramatic than that shown.)

TABLE 2. Comparison of a Municipality's Costs for an Illustrative Wastewater Treatment Project with and without Retention of User Fees*

	Construction Costs (K)			O&M Costs			Total Project Costs (TC)		
	Total	Municipality's		Total	Municipality's		Total	Municipality's	
User Fee Policy	$	$	% of Total K	$	$	% of Total O&M	$	$	% of TC
(1) *Without* Retention of User Fees	5,000,000	1,250,000	25.0	5,000,000	5,000,000	100	10,000,000	6,250,000	62.5
(2) *With* Retention of User Fees i.e., Current Policy)	5,000,000			5,000,000			10,000,000		
$\alpha = 0$		1,172,228	23.4		5,000,000	100		6,172,228	61.7
$\alpha = 1$		1,055,569	21.1		5,000,000	100		6,055,569	60.5
(3) Impact of Current User Fee Policy: Additional Federal Subsidy to the Municipality from Retention of Industrial User Fees (i.e., Row 1 − Row 2)		Between $77,772 and $194,431 additional federal subsidy to K	Between 1.6 and 3.9 increase in the federal % share of K		0	0		Between $77,772 and $194,431 additional federal subsidy to TC	Between 0.8 and 2.0 increase in the federal % share of TC

*Costs are based on the following assumptions: TC = $10,000,000; K = .50TC and C = .50TC; $\beta = .33$; $i = .10$; $n = 30$ α may equal from 0 to 1; the municipality is successful in obtaining the full grant allowable.

As an example of the method of calculation, the municipality's share of TC, under the current user fee policy, where $\alpha = 0$, is found as follows:

$$\bar{S}_M = \frac{C + .25K - D - R(.75\alpha + .25)}{TC}$$

$$= \frac{\$5{,}000{,}000 + .25(\$5{,}000{,}000) - \left[\frac{.075(.33)(\$5{,}000{,}000)}{30} - \frac{.3(.33)(5{,}000)}{30}(.75(0) + .25)\right]\frac{(1+i)^n - 1}{i(1+i)^n}}{\$10{,}000}$$

$$= \frac{\$6{,}172{,}228}{10{,}000{,}000} = .617$$

IV. FINDINGS AND RECOMMENDATIONS

We have found that the current user fee program, while completely within the law, reduces a municipality's effective share of construction and of total costs below the apparent legislated levels.

As was noted in the introduction, it has already been shown that reducing the municipality's cost share to the point at which its costs are less than its benefits at the margin will encourage the municipality to overbuild facilities, other things being equal (Marshall, 1970) and (Marshall and Ruegg, 1974). It follows that user fee arrangements which further reduce the municipality's cost share may promote overbuilding of abatement facilities. (For a discussion of factors which may account for the apparent deficit in overall pollution abatement activities in the face of possible biases to overbuild in the current cost-sharing arrangements, see Marshall and Ruegg [1974].)

A second finding of this paper is that the current user fee program reduces a municipality's effective cost share more for some kinds of abatement techniques than for others. This differential cost share reduction was found to occur for the following two reasons: First, those abatement techniques which have a relatively high proportion of their costs attributable to construction costs are more affected by the user fee program than techniques with a relatively high proportion of their costs in O&M and grant-ineligible land, other things being equal (see table 1). The effect is greater for the more construction-intensive abatement techniques because the relevant industrial user fees are collected only on construction costs. Second, the current user fee program impacts unequally among abatement techniques because the program affects a municipality's cost only for those kinds of abatement techniques which are approved for grants by the EPA Construction Grant Office; a municipality bears 100% of the total costs of ineligible techniques, with or without the user fee program. Since the Grant Office currently does not afford grant eligibility to all abatement techniques (Marshall and Ruegg, 1975), the user fee program further widens the existing difference in a municipality's cost for techniques which are eligible for federal grants, as compared with those which are ineligible. The share of project costs borne by the municipality influences its choice of techniques for providing pollution abatement, and unequal cost shares for different abatement techniques may bias municipalities to choose techniques which are not the least costly for the nation (Marshall and Ruegg, 1975; Davis, 1968; Raymond, 1973). To the extent that user fees increase the differential cost shares among techniques, a municipal bias against nationally efficient techniques may result.

As was indicated at the outset of the paper, these two effects of the user fee program serve to exacerbate existing economic inefficiencies in the cost-sharing aspects of the Construction Grant Program. Apart from the formal grant, there is no federal cost share and no federally legislated industrial user fees to be collected and retained by municipalities.

A third finding of the paper is that the rules which establish collection of user fees from industry result in insufficient federal user fee revenue to cover the federal expenditure for construction of facilities to treat industrial wastewater. User fees are insufficient for two reasons. First, part of the money is retained by the municipality for its own use. Second, no interest is charged against industrial users. The failure to charge interest results in a federal subsidy to industry and the loss of potential user fee revenue to the federal government (and/or to the municipalities which retain a portion of the money collected.)

A fourth finding of the paper is that part of the retained user fees (the discretionary fund) may be used completely as the municipality chooses. Because the municipality may choose not to use the fund for wastewater abatement, this portion of the federal subsidy may not directly further the objectives of the federal grant program.

A fifth finding is that the size of the reduction in the municipality's effective cost share induced by user fees is directly dependent upon the proportion of industrial wastewater treated in the municipal sewage system, and, accordingly, upon the degree of community industrialization. The effective cost share for a residential community is unchanged by user fees. But the effective cost share for an industrialized community which provides abatement services to industrial users in public facilities is reduced by industrial user fees collected against federally incurred costs. Having municipal cost shares that vary by the degree of community industrialization does not appear to be justifiable on economic efficiency grounds in that municipal benefits are ignored. Allowing the degree of industrialization to affect the size of municipal cost shares might also be considered inequitable if the criterion of equal or fair treatment for municipalities were anything other than degree of industrialization (e.g., average resident income). In fact, given an increased potential tax base from industry, it would appear that the allowable retained user fees to municipalities might be decreased rather than increased as the industrial sector becomes larger.

We can speculate that municipalities, as a result of experiencing reduced effective cost shares from retention of industrial user fees, will be encouraged to treat industrial wastewater in the public facilities, other things being equal. The retention of user fees enables a municipality to improve its net financial position even more by selecting construction-intensive facilities to handle industrial wastewater. As a result, we can further speculate that municipalities may see advantage in offering incentives to industry to tie into the municipal system, such as by reductions in its user charges to industry for locally-incurred construction costs. In this case, industry would receive an additional subsidy towards treatment of its wastewater beyond the federal interest subsidy.

A sixth finding of our research, perhaps obvious at this point, is that the current user fee program obscures the effective federal and municipal cost shares. As was shown in equation (8) and in table 1, the user fee program may cause the effective cost share to the municipality to differ substantially from the 25% of construction plus 100% of other costs implied by the main cost-share provision of the 1972 Act.

Finally, the legislation and regulations pertaining to user fees are difficult to understand in prose and logic, and offer possible federal cost-sharing benefits to those who have the resources to analyze them. Interpretations of the law, and, consequently, ultimate municipal cost shares are likely to differ among communities. Those whose managers are skilled in the grant process may be able to reduce their effective cost shares relative to communities with less sophisticated management.

The above described impacts of the user fee program on effective cost shares could be avoided simply by eliminating the municipality's retention of user fees collected against the federal grant. If this full amount were returned to EPA for redistribution through the regular grant process, the total amount of federal funds appropriated for abatement of wastewater pollution would be spent for that purpose, and the value of benefits resulting from the federal assistance might well be increased.

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